Rare EMC Clustering Algorithm Hiccup: Duplicate towerid(0)

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In rare events the central arm clustering algorithm assigns two clusters the same primary tower. The frequency which this occurs is so low ($\sim 10^{-7}$ event) that no modifications to the clustering alogrithm are proposed.

1 Data Selection

181 runs of type PWG_MB_run8pp_200GeV_pro82 were analyzed at CCJ.

2 Analysis Description

Whenever an event contained towers with duplicate primary towers, the event was flagged and both the emcClusterContainer and PHGlobal objects were written to a separate DST. This process yielded 97 events over 181 runs which means this occurance is extremely rare. The aggregated DST can be found in the file:

`files/kdup-PWG_MB_run8pp_200GeV_pro82-0000999999-9999.root`

3 Results

97 events were found with duplicate towerid's. The towerid's are listed below:

21981 23613 16996 22172 22659 19389 24291 23517 21308 16315 22946 21986 20541 24667 22274 22460 17958 18045 24578 18429 18629 22850 20258 21981 22653 10017 16322 21218 17179 18234 22557 18141 17954 17378 17190

21501 20642 22460 19788 16989 18629 21977 19974 18141 22468 17853 23812 16028 18525 19675 18146 23420 24098 18716 19874 20648 20931 22749 24477 23517 22946 21794 16137 21990 24482 18723 19778 20450 23037 23517 18909 24572 18812 23036 17666 17853 22370 21796 19196 17573 20355 21316 22749 21788 17757 22178 19004 23517 22938 16989 18338 21981 19196 23515 21306 24582 16418

The duplicate primary towers are all PbGl towers.

The BBC determined zvertex distribution of the flagged events is shown in figure 1.

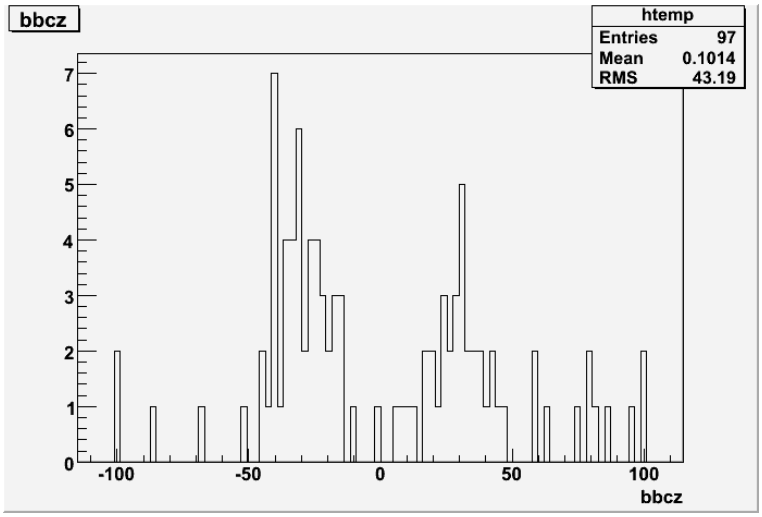

Figure 1: BBC Zvertex [cm], for events with duplicate primary towers

The correlation between zvertex and the integer tower position is shown in figures 2 and 3.

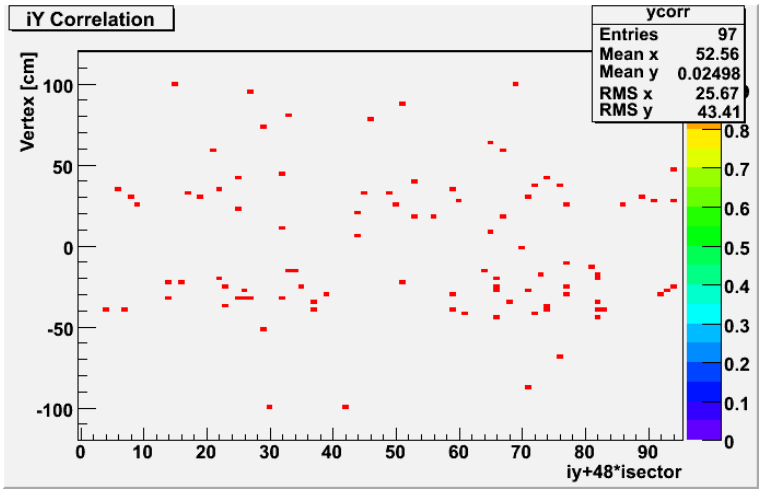

Figure 2: XAxis: EMC Tower iy* position (x) YAxis: zvertex [cm] of the event (x) ZAxis: Counts, All towers sit in the PbGl, so on the x-axis 0-47 correspond to PbGl0 (lower) while 48-95 correspond to PbGl1 (upper).

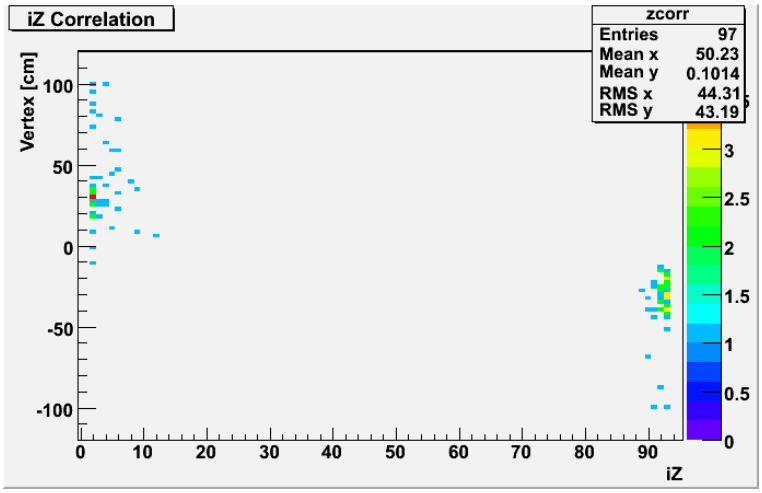

Figure 3: XAxis: EMC Tower iz position (x) YAxis: zvertex [cm] of the event (x) ZAxis: Counts

4 Duplicate Example

The following gives detailed information on the makeup of two sample clusters with the same primary tower. Notice that the clusters share the exact same towers. The energy shown for each tower differs in each cluster because partesum can be used to derive the energy contributed by the tower to a cluster. For isolated clusters, this should return the energy of the tower, but for overlapping clusters a tower will contribute different energies. See:

`https://www.phenix.bnl.gov/WWW/offline/wikioffline/index.php/How_to_analyze_EMCal_Cluster_Data:_EMCal_data_structure`

for more information

Zvertex: -23.59
EventNum: 185648

Cluster: 15
towerid(0): 20541
Energy: 0.975966

i	towerid(i)	partesum(i)-partesum(i-1)
0	20541	0.227202
1	20447	0.225018
2	20446	0.202862
3	20542	0.128205
4	20543	0.0600626
5	20445	0.0313273
6	20637	0.00283235
7	20540	0.00224304

Cluster: 16
towerid(0): 20541
Energy: 1.08293

i	towerid(i)	partesum(i)-partesum(i-1)
0	20541	0.726385
1	20542	0.0787525
2	20540	0.0611317
3	20446	0.0374129
4	20445	0.0230488
5	20637	0.0228008
6	20543	0.0173476
7	20447	0.0157105

5 Conclusion

Below are comments from Sasha Bazilevsky on the cause of the problem.

> My previous guess was partially right - it is connected with shower shape at large angles. I noticed that all such clusters (I checked about ten of them randomly) are near sector edge (and often near the corner). Actually it is not only angle problem, but also (and may be mainly) edge problem: I checked two clusters the list of towers you sent me before, and I see that one of the local maxima of the cluster is exactly on the sector edge - so it introduces bias in cluster splitting algorithm (no energy deposition information on one side from the local maximum).
>
> So, concluding, it may happen at sector edge (large impact angle) when one of the cluster local maxima is exactly at the edge, the dip between local maxima being shallow. As you showed it happens only in PbGl. PbSc is much more stable against this issue, because its shower shape is sharper than in PbGl and angle dependencies are weaker.

Assuming 1 million minimum bias events per run, the duplicate primary tower problem occurs at the 10^{-7} on the event level, or roughly at the 10^{-8} level at the cluster level. Nothing will be done to the clustering algorithm, because of the low frequency of the problem.